Canadian Food Inspection Agency
Agence canadienne d'inspection des aliments

Food Safety Action Plan

REPORT

2011-2012 Targeted Surveys

Targeted Survey Investigating Bacterial Pathogens and Generic *E. coli* in Tomatoes in the Canadian Market

RDIMS # 4087959

Canada

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Executive Summary

The Food Safety Action Plan (FSAP) aims to modernize and enhance Canada's food safety system in order to better protect Canadians from unsafe food and ultimately reduce the occurrence of foodborne illness.

In the last decade, fresh fruits and vegetables have been increasingly reported in association with foodborne illnesses, with tomatoes being the second most frequent vehicle for produce-associated outbreaks. Although these outbreaks have been mainly reported in the U.S., the microbiological quality of tomatoes in Canada remains a concern, as the supply sources are similar in both countries. The outbreaks associated with tomatoes have been predominantly linked to *Salmonellae*, followed by Norovirus and Hepatitis A. From 1990 to 2011, 31 foodborne disease outbreaks involving nearly 4,000 cases were associated with tomatoes contaminated with bacterial or viral pathogens. Production practices and growing conditions can affect the microbial load of tomatoes. Furthermore, in the past decade there has been a rapid increase in the market share for tomatoes grown using organic practices. The use of composted animal manure and plant debris in the production of organic produce has raised concerns about an increased likelihood of contamination with pathogens.

Considering these factors and their relevance to Canadians, tomatoes have been selected as one of the priority commodity groups of fresh fruits and vegetables for enhanced surveillance under the FSAP. Over the course of a five-year baseline study (2008/09 - 2012/13), approximately 5,000 tomato samples were collected from Canadian retail locations and tested for various food pathogens of concern.

The main objectives of the 2011/12 survey were to generate baseline surveillance data on bacterial pathogens *Salmonella*, *Shigella* and *Escherichia coli* (*E. coli*) O157, as well as on the indicator of fecal contamination generic *E. coli*, for a variety of tomatoes available in the Canadian market. A total of 1742 samples from various countries and production practices were collected and analyzed. The results indicate that bacterial pathogens were not detected in any of the tomato samples and levels of generic *E. coli* were always found to be acceptable. All tested samples were assessed as satisfactory. These results suggest that the tomatoes in the Canadian market sampled during this survey were produced under Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs).

The Canadian Food Inspection Agency (CFIA) regulates and provides oversight to the industry, works with provinces and territories, and promotes safe handling of foods throughout the food production chain. However, it is important to note that the food industry and retail sectors in Canada are ultimately responsible for the food they produce and sell, while individual consumers are responsible for the safe handling of the food they

have in their possession. Moreover, general advice for the consumer on the safe handling of foods is widely available. The CFIA will continue its surveillance activities and inform stakeholders of its findings.

1 Introduction

1.1 Food Safety Action Plan

In 2007, the Canadian government launched a five-year initiative in response to a growing number of product recalls and concerns about food safety. This initiative, called the Food and Consumer Safety Action Plan (FCSAP) (1), aims to modernize and strengthen Canada's safety system for food, health and consumer products. The FCSAP initiative unites multiple partners in ensuring safe food for Canadians.

The Canadian Food Inspection Agency's (CFIA) Food Safety Action Plan (2) is one element of the government's broader FCSAP initiative. The goal of FSAP is to identify risks in the food supply, limit the possibility of occurrence of these risks, improve import and domestic food controls, and identify food importers and manufacturers.

Within the FSAP, there are 12 main areas of activity, one of which is risk mapping and baseline surveillance. The main objective of this area is to better identify, assess and prioritize potential food safety hazards through risk mapping, information gathering and analysis of foods in the Canadian marketplace. Targeted surveys are one tool used to test for the presence and level of particular hazards in specific foods.

1.2 Targeted Surveys

Targeted surveys are used to gather information regarding the potential occurrence of hazards in food commodities. The microbiological targeted surveys aim to establish baseline data on priority and/or emerging microbiological hazards in targeted commodities, primarily fruits and vegetables and imported food ingredients. A statistically significant number of samples were collected over five years to allow for seasonal and/or production variations. This work differs from regular CFIA microbiological monitoring activities which test samples of a broad range of commodities for multiple hazards and are aimed to determine the compliance of defined lots with established microbial standards or guidelines for regulatory purposes.

To identify food-hazard combinations of greatest potential health risk for the targeted surveys, the CFIA uses a combination of scientific literature, documented outbreaks of foodborne illness, and/or information gathered from the Food Safety Science Committee (FSSC), a group of Canadian federal, provincial and territorial subject matter experts in the area of food safety (3).

This targeted survey (2011/12) represents part of the collection of approximately 5,000 tomato samples over a five-year baseline study (2008/09 - 2012/13) and was designed to

gather baseline information on the occurrence of microbial pathogens of concern, as well as the presence and levels of generic *E.coli* in tomatoes available to Canadians at retail.

1.3 Codes of Practice, Acts, and Regulations

International food safety standards, codes of practice, and guidelines relating to food, food production, and food safety are developed under the joint Food and Agriculture Organization of the United Nations /World Health Organization (FAO/WHO) Codex Alimentarius Commission. Producers of fresh fruits and vegetables are encouraged to follow these international codes of practice. Of relevance for this survey are the *Code of Hygienic Practice for Fresh Fruits and Vegetables* (CAC/RCP 53-2003) (4) and the *Recommended International Code of Practice - General Principles of Food Hygiene* (CAC/RCP 1-1969) (5). These codes address Good Agricultural Practices (GAPs) and Good Manufacturing Practices (GMPs) which, when applied, control and reduce the potential for contamination with microbial, chemical, and physical hazards at all stages of the production of fresh fruits and vegetables from primary production to packaging.

Fresh fruits and vegetables available in the Canadian market must comply with the *Food and Drugs Act* (FDA) (6) and the *Food and Drug Regulations* (FDR) (7), which prescribe certain restrictions on the production, importation, sale, composition and content of foods and food products. Section 4(1)a of the FDA prohibits the sale of food contaminated with foodborne pathogens, while sections 4(1)e and 7 prohibit the sale of unsafe food and food produced under unsanitary conditions.

Fresh fruits and vegetables that are imported in Canada or domestically produced and marketed inter-provincially must also comply with safety requirements of the *Fresh Fruit and Vegetable Regulations* (8) under the *Canada Agricultural Products Act* (9). These regulations are intended to ensure that fresh fruits and vegetables sold to consumers are safe, wholesome and properly graded, packaged and labeled.

The *Fresh Fruit and Vegetable Regulations*, and the food-related sections of the FDA and FDR are enforced by the CFIA.

FSAP targeted surveys are primarily conducted for surveillance and not for regulatory compliance purposes. However, results indicating a potential risk to public health for any samples tested under this survey will trigger food safety investigations, including activities such as follow-up sampling, inspections of facilities and health risk assessments. Depending on the findings, a recall of the affected product may be warranted.

2 Survey on Pathogens in Tomatoes

2.1 Rationale

Tomatoes have been reported to be responsible for numerous outbreaks of foodborne illnesses worldwide. From 1990 to 2011, 31 foodborne disease outbreaks involving nearly 4,000 cases were associated with tomatoes contaminated with bacterial or viral pathogens. These outbreaks have been predominantly linked to *Salmonella,* followed by Norovirus and Hepatitis A virus, and were reported worldwide, with most of reported cases occurring in North America (Appendix B). According to the U.S. Centers for Diseases Control and Prevention, five produce commodity groups made up 76% of associated foodborne disease outbreaks between 1998 and 2006. Of these, 17% of the outbreaks were linked to tomatoes, which are the second most frequent vehicle of produce-associated outbreaks (10). In 2011, there were a number of recalls associated with the presence of *Salmonella* in grape tomatoes (Appendix C).

Tomatoes are a significant fresh produce commodity for Canada (11). Over the years, the variety of tomatoes available on the Canadian market has changed significantly, and there has been an increasing share of organically grown tomatoes (12). Furthermore, the production of field tomatoes has decreased while the production of greenhouse tomatoes has increased (13).

Production practices can affect the microbial load of tomatoes. For example the use of improperly composted animal manure has led to concerns about the potential contamination of produce with human pathogens. Since organic productions are more reliant on the use of manure to fertilize fields, it has been suggested, while not proven to this day, that organic produce may face higher levels of microbial contamination. However, studies suggest that there are likely no differences between organic and conventional produce in microbial safety if GAPs are followed in organic manure applications (14, 15).

Tomatoes may become contaminated with pathogens if handled improperly during primary production, harvesting, post-harvest handling, processing and/or distribution and, subsequently, can cause foodborne illness. Pathogens such as *Salmonella*, *Shigella* and *E. coli* O157 can be present on fruits and vegetables due to fecal contamination or poor hygiene practices during production (16, 17).

Based on the above information, tomatoes have been selected for targeted surveillance under FSAP. The overall objective is to generate baseline information to gain insights on the occurrence of pathogens of concern and indicators of fecal contamination in these commodities available to Canadians at retail.

This targeted survey (2011/12) is part of the information collection with a focus on investigating the presence and distribution of bacterial pathogens, as well as the presence, distribution, and levels of generic *E. coli* (as an indicator of fecal contamination) in imported and domestic, conventionally and/or organically grown tomatoes.

2.2 Targeted Microorganisms

2.2.1 Bacterial Pathogens of Concern

Bacterial pathogens *Salmonella* and *E. coli* O157 are found naturally in the intestines of animals, such as poultry and cattle respectively (18). Most outbreaks associated with these bacterial pathogens are linked to consumption of contaminated food of animal origin (chicken and beef burger). However, in the last decade, fresh fruits and vegetables have emerged as significant sources of these bacterial pathogens related illnesses (19). Fruits and vegetables can be contaminated with these bacterial pathogens in the field by improperly composted manure, contaminated water, wildlife feces, or poor hygienic practices of the farm workers (20).

Humans are the only host of the bacterial pathogen *Shigella*. Food contaminated by infected food handlers with poor personal hygiene, and water contaminated with human feces are the most common causes of shigellosis. Shigellosis illnesses have been known to be associated with consumption of contaminated fruits, vegetables, shellfish and chicken (18).

2.2.2 Generic *E. coli* - an Indicator of Fecal Contamination

Typically, *E. coli* bacteria that inhabit the large intestines of humans and animals are harmless. Due to their regular presence in the stools of humans and animals, the occurrence of *E. coli* in foods indicates direct or indirect contamination with fecal matter (21). The presence of generic *E. coli* in foods can also indicate potential contamination with pathogenic enteric microorganisms, such as *Salmonella* or *E. coli* O157, that also live in the intestines of infectious humans and animals. It is important to note that the presence of generic *E. coli* in food only implies an increased risk of contamination with pathogenic microorganisms but does not conclusively indicate that these pathogenic organisms are present. High levels of generic *E. coli* in fresh produce sold at retail are an indication that contamination has occurred at some point between production and the time of sale.

2.3 Sample Collection

All samples were collected from national chain and local/regional grocery stores, as well as other conventional retail and natural food stores located in various cities across Canada. There were a number of varieties of tomatoes collected for the survey including, Beefsteak, plum, cherry, grape and Campari varieties.

The number of samples collected in the various regions was based on the relative proportion of the population in the respective regions. Domestic samples were collected during the summer months (June-September). Imported samples were collected primarily in the fall, winter, and spring months. Samples that were labelled as organic at retail were identified as "organic" in this survey. Other samples were identified as "conventional".

In this survey, a sample consisted of a single sample unit, i.e., tomatoes selected randomly from bulk or individual consumer size packages with a total weight of no less than 200 g. This sampling approach is typical for surveys conducted at retail, and is also used by other federal partners such as the Public Health Agency of Canada (PHAC) for the retail component of their C-EnterNet surveys (22). Collected samples were required to be shipped under conditions that limited the growth of microorganisms during transit. Samples were declared "unfit" for analysis if there were issues regarding the conditions in which the sample was handled or shipped.

2.4 Sample Distribution

As per survey design, a total of 1742 tomato samples were collected and analyzed for selected bacteria. The distribution by product type and by country of origin is presented in Table 1.

Table 1 Sample Distribution by Country of Origin and Production Practices

Country of Origin	Organically Grown		Conventionally Grown		Total
	Number of Samples	Percentage of Total (%)	Number of Samples	Percentage of Total (%)	
Canada	396	22.7	202	11.6	598
Guatemala	0	0.0	2	0.1	2
Israel	4	0.2	0	0.0	4
Italy	0	0.0	6	0.3	6
Mexico	486	27.9	379	21.8	865
United States	57	3.3	206	11.8	263
Unknown	2	0.1	2	0.1	4
Total Imported	549	31.5	595	34.2	1144
Total	**945**	**54.2**	**797**	**45.8**	**1742**

Domestic samples accounted for one third, or approximately 34.3% of all samples, while the remainder were imported. Organic tomatoes comprised 54.2%, while conventional tomatoes accounted for 45.8% of the survey. The majority of imported samples were from Mexico (865/1144 in total, 75.6%). The remaining samples came from the United States (263/1144, 23.0%), and a small number from Italy (6/1144, 0.5%), Israel (4/1144, 0.3%) and Guatemala (2/1144, 0.2%). Four samples (0.3%) were of unknown origin.

2.5 Method Details

Samples were analysed using the analytical methods published in Health Canada's *Compendium of Analytical Methods* for the Microbiological Analysis of Foods (23) (Appendix D). These methods are used for regulatory testing by the CFIA and are fully validated for the analysis of fresh fruits and vegetables, including tomatoes. A modified version of the method from Health Canada's Compendium was used for *Salmonella* testing as indicated in Appendix D.

For the detection of *E. coli* O157:H7/NM, *Salmonella,* and *Shigella*, samples were analyzed by enrichment and confirmed by isolation, purification and identification procedures. The laboratories also had the option of screening enrichment broths by polymerase chain reaction (PCR)-based methods, followed by confirmation of presumptive positives.

Enumeration of generic *E. coli* was accomplished by the most probable number (MPN) or direct plating procedure.

If pathogens were detected, the isolates would be further characterised by pulsed field gel electrophoresis (PFGE), i.e., DNA typing at the CFIA's PFGE Centre. Serotyping for *Salmonella* spp. is performed at the *Salmonella* Typing Laboratory, Laboratory for Foodborne Zoonoses, PHAC, in Guelph, Ontario. Serotyping for *Shigella* is performed at the National Microbiology Laboratory, PHAC, in Winnipeg, Manitoba.

2.6 Assessment Guidelines

The assessment criteria used in this survey (Tables 2 and 3) are based on the principles of the *Health Products and Food Branch Standards and Guidelines for Microbiological Safety of Foods* (24) and associated methods published in Health Canada's *Compendium of Analytical Methods* (23).

Table 2 Assessment Guidelines for Bacterial Pathogens in Tomatoes

Bacterial Analysis* **(Method Identification Number)**	**Assessment Criteria**	
	Satisfactory	**Unsatisfactory**
E. coli O157:H7/NM (MFLP-30 with Supplements 1 & 2, and MFLP-80(if required for confirmation))	Absent in 25 g	Present in 25 g
Salmonella* spp.* (MFLP-29 modified and MFHPB-20(if required for confirmation))	Absent in 25 g	Present in 25 g
Shigella* spp.* (MFLP-26 and MFLP-25(if required for confirmation))	Absent in 25 g	Present in 25 g

* *Compendium of Analytical Methods* (23).

**No criteria have been established by Health Canada at this time for these bacterial pathogens in fresh fruits and vegetables. However, in the absence of a specified criteria, the presence in foods is considered to be a violation of FDA Section 4(1)a and is therefore assessed by the CFIA as unsatisfactory.

Table 3 Assessment Guidelines for Generic *E. coli* in Tomatoes

Bacterial Analysis* (Method Identification Number)	Assessment Criteria		
	Satisfactory	**Investigative**	**Unsatisfactory**
Generic *E. coli* (MFHPB-19 or MFHPB-27)**	≤ 100 /g	100 < x ≤ 1000 /g	> 1000 /g

* *Compendium of Analytical Methods* (23).

** Concentration unit for MFHPB-19 method: MPN/g: and for MFHPB-27 method: CFU/g.

Based on the current regulatory standards and microbiology testing criteria, results of this survey were assessed as "satisfactory", "unsatisfactory", or "investigative".

Unsatisfactory sample assessments were subject to follow-up actions, such as directed follow-up sampling, inspection of establishment, health risk assessment, and/or product action (e.g., product recall).

Samples assessed as investigative in this survey required some follow-up activity. This could include, for example, further sampling (to verify the levels of generic *E. coli* in the samples in question) or data gathering for program design purposes.

2.7 Limitations

Samples tested during this survey were collected at retail locations across Canada, as opposed to monitoring samples that are picked up at distribution points and warehouses. As such, products sampled at retail could be mixed and originate from different shipments and/or suppliers. Though this represents what the Canadian consumer experiences, this imposes certain limitations with respect to the traceability of the products and the identification of the source of contamination in the case of positive results.

Results obtained for a targeted survey sample are from the analysis of a single sample unit. This sampling and testing strategy generally precludes the extrapolation of the laboratory result to the whole production lot as it is not statistically representative. This imposes certain limitations in the interpretation of the results to the specific lot in the absence of additional information.

Finally, given the seasonality, as well as the varying channels of commerce, the source of the products can change dramatically from one season to the next. As such, there is an insufficient number of samples in this survey to carry out a detailed analysis of the results based on country of origin. In cases of positive results, unsatisfactory rates between countries are not considered to be statistically comparable.

3 Results

A total of 1742 tomato samples were tested for *Salmonella*, *Shigella*, *E. coli* O157:H7/NM, and the indicator bacteria, generic *E. coli*. The results of the survey (Table 4) indicate that the bacterial pathogens *Salmonella*, *Shigella* and *E. coli* O157 were not detected in any of the tested samples, and generic *E. coli* was not found at levels exceeding the satisfactory threshold. All samples that were analyzed during this survey were assessed as satisfactory.

Table 4 Summary of Results for Tomato Samples

Type of Product		Number of Samples	Assessment		
			Satisfactory	Investigative	Unsatisfactory
Conventional	Domestic	202	202	0	0
	Imported	595	595	0	0
Organic	Domestic	396	396	0	0
	Imported	549	549	0	0
Total		**1742**	**1742 (100%)**	0	0

4 Discussion and Conclusion

The results of this 2011/12 survey indicate that no pathogens were detected in any of the 1742 tomato samples analyzed. Furthermore, fecal contamination indicator generic *E. coli* was either not detected or detected at levels that were satisfactory in all of the samples tested for this indicator organism.

The overall finding of this survey suggests that tomatoes in the Canadian market available at the time of this survey were produced and handled under acceptable GAPs and GMPs.

While the food industry and retail sectors in Canada are ultimately responsible for the food they produce and sell, and individual consumers are responsible for the safe handling of the food they have in their possession, the CFIA regulates the food industry, provides oversight and promotes safe handling of foods throughout the food production chain. Surveillance activities will continue and the CFIA will inform stakeholders of its findings.

5 Acknowledgment

We would like to express our sincere thanks to Judy D. Greig, Laboratory for Foodborne Zoonoses, Public Health Agency Canada, for providing data on global foodborne disease outbreaks associated with tomatoes (Appendix B).

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Appendix A: List of Acronyms

CFIA: Canadian Food Inspection Agency
CDC: Centres for Disease Control and Prevention
CFU: colony forming unit
E. coli: *Escherichia coli*
FAO: Food and Agriculture Organization of the United Nations
FDA: *Food and Drugs Act*
FDR: *Food and Drug Regulations*
FCSAP: Food and Consumer Safety Action Plan
FSAP: Food Safety Action Plan
GAPs: Good Agricultural Practices
GMPs: Good Manufacturing Practices
HPB/MFHPB: Health Protection Branch/ Microbiology Food Health Protection Branch
MFLP: Microbiology Food Laboratory Procedures
MPN: Most Probable Number
NM: non-motile
PCR: Polymerase Chain Reaction
PFGE: Pulsed Field Gel Electrophoresis
PHAC: Public Health Agency of Canada
spp.: species
USFDA: United States Food and Drug Administration
WHO: World Health Organization
°C: Degree Celsius
g: gram

Appendix B: Global Foodborne Disease Outbreaks Associated with Tomatoes Contaminated with Bacterial or Viral Pathogens (1990-2011)*

Microorganism	Location	Cases	Source	Narrative
Campylobacter	Ohio, 2004	13	CDC line list 2004	
Hepatitis A virus	France, 2010	55	French institute of Public Health	Dried tomatoes, used in sandwiches and salads.
Hepatitis A virus	Australia, 2009	200	South Australian director of public health	On-going outbreak of HAV in Australia that has sickened about 200 people and appears to be linked to semi-dry tomatoes.
Hepatitis A virus	Netherlands, 2009	13	Eurosurveillance, Volume 15, Issue 20, 2010	Imported product-source not reported: semi-dried tomatoes in oil.
Hepatitis A virus	Tennessee, 2005	23	CDC line list 2005	
Norovirus	Ohio, 2000	31	CDC line list 2000	
Norovirus	California, 2002	50	CDC line list 2002	
Norovirus	Connecticut, 2004	92	CDC line list 2004	
Norovirus	Colorado, 2005	17	CDC line list 2005	
Norovirus	Colorado, 2007	33	CDC line list 2007	
Salmonella	Multiple US states, 2004	429	MMWR 2005/54(40);325-328.	129 hospitalized; 9 states (Maryland, Michigan, Missouri, North Carolina, New Hampshire, Ohio, Pennsylvania, Virginia, & West Virginia) associated with dining at delicatessen chain A. These cases yielded S. Javiana (383), S. Typhimurium (27), S. Anatum (5), S. Thompson (4)
Salmonella	Minnesota, 2007	22	Post-Bulletin, Rochester MN	1 hospitalized; Tomatoes were contaminated before they got to the restaurant.
Salmonella Baildon	Multiple US states, 1998	86	Emerg Infect Dis. 2001 7(6):1046-8	Raw restaurant-prepared tomatoes likely contaminated on the farm or during packing were implicated in outbreak. Traceback identified tomato grower/packer cooperatives, in Florida, & a tomato dicing operation in California. Dicing & pooling may have played a role.
Salmonella Berta	Multiple US states, 2006	16	CDC linelist 2006	4 hospitalized;
Salmonella Braenderup	Multiple US states, 2004	137	MMWR 2005/54(40);325-328.	25 hospitalized;16 states (Delaware, Connecticut, Georgia, Iowa, Kansas, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Virginia, West Virginia, & Wisconsin) Roma tomatoes
Salmonella Braenderup	Multiple US states, 2005	84	CDC line list 2005	

Microorganism	Location	Cases	Source	Narrative
Salmonella Norfolk	Multiple US states, 2006	106	CDC	37 hospitalized; Federal officials are investigating a second Salmonella outbreak linked to restaurant tomatoes that has sickened 106 people in 19 states.
Salmonella Javiana	Ontario, 2004	7	MMWR 2005/54(40);325-328. CCDR Volume 31-21 2005	1 hospitalized; Indistinguishable PFGE patterns, but with patterns distinct from the multiserotype Salmonella outbreak, were identified from Ontario. All patients ate at the same restaurant. Roma tomatoes
Salmonella Javiana	Multiple US states, 1990	176	Epidemiol Infect 1999 122(3):385-93	Illinois, Michigan, Minnesota and Wisconsin - 1990 (176 cases of S. Javiana) Case-control studies & traceback implicated consumption of tomatoes from a single South Carolina tomato packer. Contamination likely occurred at the packing shed.
Salmonella Javiana	Florida, 2002	159	MMWR 2002 51(41):683-4; Emerg Infect Dis. Vol 11 2005; 610-612	3 hospitalized; Transplant Games, an Olympics-style athletic competition among recipients of solid organ & bone marrow transplants in Orlando, Florida: 75 reported eating food items at specific food courts in theme park. Illness associated with eating dishes containing diced Roma tomatoes.
Salmonella Montevideo	Multiple US states, 1993	100	Epidemiol Infect 1999 122(3):385-93	Illinois, Michigan, Minnesota and Wisconsin - Case-control studies & traceback implicated consumption of tomatoes from a single South Carolina tomato packer. Contamination likely occurred at the packing shed.
Salmonella Newport	Multiple US states, 2002	510	CDC line list 2002	
Salmonella Newport	Multiple US states, 2005-2006	459	MMWR Weekly Volume 56, No. 35 2007	During 2005--2006, four large multistate outbreaks of Salmonella infections associated with eating raw tomatoes at restaurants occurred in the United States. The four outbreaks resulted in 459 culture-confirmed cases of salmonellosis in 21 states.
Salmonella Newport	Multiple US states, 2007	65	CDC line list 2007	11 hospitalized; beefsteak tomatoes
Salmonella Newport	New York, 2007	10	CDC line list 2007	unspecified type; 1 death; 4 hospitalized;
Salmonella Strathcona	Multiple, 2011	58	ProMED Digest V2012 #369	Denmark (43 cases), Germany (14 cases) and Austria (1 case) Small, elongated tomatoes (datterino) from Italy identified as source of infections.
Salmonella Thompson	Multiple US states, 2000	43	CDC line list 2000	
Salmonella Typhimurium	Minnesota, 2007	23	CDC line list 2007	1 hospitalized;
Salmonella Virchow	California, 2003	11	CDC line list	
Salmonella	Australia, 1998	32	Epidemiology and Infection Volume	S. Virchow (42) was cultured from 2 brands of semi-dried tomatoes

Virchow PT8			131, Issue 3 (pp. 1041-1048)	associated with cases in 2 states. 1 death; 12 hospitalized
Microorganism	**Location**	**Cases**	**Source**	**Narrative**
Shigella flexneri 2a	New York, 2001	886	Clinical Infectious Diseases 2006;42:163-9	22 hospitalized; Outbreak involved 5 local restaurants under the same ownership. Consumption of tomatoes was the only exposure that remained significant in multiple multivariable models.

* Information in the Appendix B was prepared by Judy D. Greig, Laboratory for Foodborne Zoonoses , PHAC (Public Health Agency of Canada)

Appendix C: Tomato Recalls in the U.S. and Canada (2011)

Date of Issue	Recalled Products	Reason for Recall	Authority
2011-05	Grape Tomatoes (various locations)	*Salmonella*	USFDA**
2011-05	Cherry Tomatoes: U.S. products	*Salmonella*	CFIA*
2011-05	Grape Tomatoes	*Salmonella*	USFDA
2011-09	Organic Grape Tomatoes	*Salmonella*	CFIA/ USFDA
2011-10	Grape Tomatoes	*Salmonella*	USFDA
2011-11	Grape Tomatoes	*Salmonella*	USFDA

* CFIA Food Recall Archives http://epe.lac-bac.gc.ca/100/206/301/cfia-acia/2011-09-21/www.inspection.gc.ca/english/corpaffr/recarapp/recal2e.shtml

** Recalls, Market Withdrawals, & Safety Alerts http://www.fda.gov/safety/recalls/

Appendix D: Analytical Methods Used for Microbial Analysis

Microbial Analysis	Method Identification Number (Date Issued)*	Title of Method
***E. coli* O157:H7/NM**	MFLP-30 (May 2003, Supplement 1 May 2005 & Supplement 2 November 2006)	The Dupont Qualicon Bax® System Method for the Detection of *E. coli* O157:H7 in Raw Beef and Fruit Juice
	MFLP-80 (March 2008)	Isolation of *E. coli* O157:H7 or NM in Foods
***Salmonella* spp.**	MFLP-29** (July 2007, modified)	The Qualicon Bax® System Method for the Detection of *Salmonella* in a Variety of Food and Environmental Samples
	MFHPB-20 (March 2009)	Methods for the Isolation and Identification of *Salmonella* from Foods and Environmental Samples
***Shigella* spp.**	MFLP-26 (February 2006)	Detection of *Shigella* spp. In Foods by the Polymerase Chain Reaction (PCR)
	MFLP-25 (March 2006)	Isolation and Identification of *Shigell*a spp. From Foods
Generic *E. coli*	MFHPB-19 (April 2002)	Enumeration of Coliforms, Faecal Coliforms and of *E. coli* in Foods
	MFHPB-27 (September 1997)	Enumeration of *Escherichia coli* in Foods by the Direct Plating (DP) Method

* In *the Compendium of Analytical Methods* (23).

** MFLP-29 was performed as written with the following modification: Secondary enrichment was performed as outlined for cantaloupes, i.e., transferred from buffered peptone broth as specified to RVS and TBG broths (Rappaport-Vassiliadis Soya Peptone broth and Tetrathionate Brilliant Green broth) and incubated for 24 ± 2 h at 42.5°C. After incubation 2 ml from each of RVS and TBG are combined to one sample and proceed with step 7.3.1.4 of the method.